Society of Automotive Engineers, Inc.
400 COMMONWEALTH DRIVE, WARRENDALE, PA. 15096

# AEROSPACE MATERIAL SPECIFICATION

AMS 5591E
Superseding AMS 5591D
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## STEEL TUBING, SEAMLESS, CORROSION AND MODERATE HEAT RESISTANT 12.5Cr (SAE 51410)



1. SCOPE:

1.1 Form: This specification covers a corrosion and moderate heat resistant steel in the form of seamless tubing.

1.2 Application: Primarily for parts and assemblies requiring corrosion resistance and oxidation resistance up to 1000° F (538° C), but useful at the higher temperatures only when stresses are low.

1.2.1 Certain design and processing procedures may cause this material to be susceptible to stress-corrosion cracking after heat treatment; ARP 1110 recommends practices to minimize such conditions.

2. APPLICABLE DOCUMENTS: The following publications form a part of this specification to the extent specified herein. The latest issue of Aerospace Material Specifications (AMS) and Aerospace Recommended Practices (ARP) shall apply. The applicable issue of other documents shall be as specified in AMS 2350.

2.1 SAE Publications: Available from Society of Automotive Engineers, Inc., 400 Commonwealth Drive, Warrendale, Pennsylvania 15096.

2.1.1 Aerospace Material Specifications:

AMS 2243 - Tolerances, Corrosion and Heat Resistant Steel Tubing
AMS 2248 - Chemical Check Analysis Limits, Wrought Heat and Corrosion Resistant Steels and Alloys
AMS 2350 - Standards and Test Methods
AMS 2371 - Quality Assurance Sampling of Corrosion and Heat Resistant Alloys, Wrought Products Except Forgings

2.1.2 Aerospace Recommended Practices:

ARP 1110 - Minimizing Stress-Corrosion Cracking in Heat Treatable Wrought Low-Alloy and Martensitic Corrosion-Resistant Steels

2.2 ASTM Publications: Available from American Society for Testing and Materials, 1916 Race Street, Philadelphia, Pennsylvania 19103.

ASTM A370 - Mechanical Testing of Steel Products
ASTM E353 - Chemical Analysis of Stainless, Heat-Resisting, Maraging, and Other Similar Chromium-Nickel-Iron Alloys

2.3 Government Publications: Available from Commanding Officer, Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, Pennsylvania 19120.

2.3.1 Federal Standards:

Federal Test Method Standard No. 151 - Metals; Test Methods

3. TECHNICAL REQUIREMENTS:

3.1 Composition: Shall conform to the following percentages by weight, determined by wet chemical methods in accordance with ASTM E353, by spectrographic methods in accordance with Federal Test Method Standard No. 151, Method 112, or by other approved analytical methods:

| | min | max |
|---|---|---|
| Carbon | -- | 0.15 |
| Manganese | -- | 1.00 |
| Silicon | -- | 1.00 |
| Phosphorus | -- | 0.040 |
| Sulfur | -- | 0.030 |
| Chromium | 11.50 | 13.50 |
| Nickel | -- | 0.75 |
| Molybdenum | -- | 0.60 |
| Aluminum | -- | 0.05 |
| Nitrogen (3.1.1) | -- | 0.08 |
| Copper | -- | 0.50 |
| Tin | -- | 0.05 |

3.1.1 Determination not required for routine acceptance.

3.1.2 Check Analysis: Composition variations shall meet the requirements of AMS 2248.

3.2 Condition: Cold drawn, annealed, and descaled.

3.3 Fabrication: Tubing shall be produced by a seamless process. The external and internal surface finishes may be produced by pickling, bright annealing, or any method which will provide the required surface condition and which will not affect limits of wall thickness or corrosion resistance, with the exception that centerless ground finish is not acceptable. A light polish to improve surface appearance may be employed after the final anneal. Passivation treatment shall follow any surface treatment used.

3.4 Properties: The product shall conform to the following requirements; hardness and tensile testing shall be performed in accordance with ASTM A370:

3.4.1 Tensile Properties: Shall be as follows:

| | |
|---|---|
| Tensile Strength, max | 100,000 psi (690 MPa) |
| Elongation in 2 in. (50.8 mm), min | |
| Strip | 20% |
| Full Section | 25% |

3.4.2 Response to Heat Treatment: Full sections of tubing or specimens cut from tubing, heated to 1750° F ± 10 (954.4° C ± 5.6), held at heat for 30 min. ± 3, and cooled in still air, shall have tensile strength not lower than 150,000 psi (1034 MPa) or equivalent hardness.

3.4.3 Flarability: Tubing shall be capable of being flared without formation of cracks or other visible defects. The specimen shall, at room temperature, be forced axially with steady pressure over a hardened and polished tapered steel pin having a 74 deg (1.29 rad) included angle to produce a flare having a permanent expanded OD not less than 1.35 times the nominal diameter.

3.5 Quality: Tubing shall be uniform in quality and condition and shall have a workmanlike finish conforming to the best practice for high quality tubing. It shall be smooth, clean, and free from heavy scale or oxide, burrs, seams, tears, grooves, laminations, slivers, pits, and other injurious conditions. Ø Surface imperfections such as handling marks, straightening marks, light mandrel and die marks, shallow pits, and scale pattern will not be considered injurious if the imperfections are removable within the tolerances specified for wall thickness. The removal of surface imperfections is not required.

3.6 Sizes: Except when exact lengths or multiples of exact lengths are ordered, tubing will be acceptable Ø in mill lengths of 6 - 20 ft (1.8 - 6.1 m) but not more than 10% of any shipment shall be supplied in lengths shorter than 10 ft (3 m).

3.7 Tolerances: Unless otherwise specified, tolerances shall conform to all applicable requirements of AMS 2243.

4. QUALITY ASSURANCE PROVISIONS:

4.1 Responsibility for Inspection: The vendor of tubing shall supply all samples and shall be responsible Ø for performing all required tests. Results of such tests shall be reported to the purchaser as required by 4.4. Purchaser reserves the right to perform such confirmatory testing as he deems necessary to assure that the tubing conforms to the requirements of this specification.

4.2 Classification of Tests:

4.2.1 Acceptance Tests: Tests to determine conformance to composition (3.1), tensile property (3.4.1), Ø response to heat treatment (3.4.2), and tolerance (3.7) requirements are classified as acceptance or routine control tests.

4.2.2 Qualification Tests: Tests to determine conformance to flarability (3.4.3) requirements are classi- Ø fied as qualification or periodic control tests.

Ø 4.3 Sampling: Shall be in accordance with AMS 2371 and the following:

4.3.1 Specimens for flarability test may be cut from any portion of a tube or an entire tube may be used as a specimen. The end of the specimen to be flared shall be cut square, with the cut end smooth and free from burrs, but not rounded.

4.4 Reports:

4.4.1 The vendor of tubing shall furnish with each shipment three copies of a report of the results of tests for chemical composition of each heat in the shipment, the results of tests for tensile properties Ø and response to heat treatment of each size from each heat, and a statement that the tubing conforms to the other technical requirements of this specification. This report shall include the purchase order number, heat number, material specification number and its revision letter, size, and quantity from each heat.

4.4.2 The vendor of finished or semi-finished parts shall furnish with each shipment three copies of a report showing the purchase order number, material specification number and its revision letter, contractor or other direct supplier of tubing, part number, and quantity. When tubing for making parts is produced or purchased by the parts vendor, that vendor shall inspect each lot of tubing to determine conformance to the requirements of this specification, and shall include in the report a statement that the tubing conforms, or shall include copies of laboratory reports showing the results of tests to determine conformance.

Ø 4.5 Resampling and Retesting: Shall be in accordance with AMS 2371.